Final Report Submitted to:

Human Dimensions of Global Change Research (HDGCR) Program: Project Title:

"Support of a Climate-Informed Water Bank"

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I. Preliminary Materials.

A. Project Abstract (Text Limit: one page)

This project builds on earlier work in the Arkansas Valley of Colorado (as part of a set of case studies) that previously identified the actual and potential uses of climate information by water managers. (see final report of 05/20/04, Howe, et al., Exploratory Assessment of Potential for Improved Water Resources Management by Increased Use of Climate Information in Three Western States and Selected Tribes). The Drought centered on 2002 increased appreciation of climate-responsive flexibility in water management. Urban growth has dramatically increased pressure to transfer agricultural water to urban areas, and supply-demand imbalances are much better understood now with the Statewide Water Supply Initiative reporting (see <cwcb.state.co.us/IWMD/General.htm>). Sharply increased competition for agricultural water has actually decreased interest in prices for water acquisition, which we intended to be the main focus, because infrastructure and externality issues became so important in the new policy process. New institutions have been created in response to drought-related problems in Colorado and in the Arkansas Basin in particular. The "water bank" idea had long been regarded as the answer to many problems, and various applications have appeared in the West (Clifford, et al.<http://www.ecy.wa.gov/biblio/0411011>). In Colorado, the first experiment in the Arkansas Valley was problematic. The Arkansas Pilot Water Bank failed to function. As a result, this project was diverted into analysis, explanation and discussion of the failure of that Water Bank. This effort included public discussion, consultations and discussions with State Engineer's Office personnel, contact with a wide range of officials and extension agents, and on-going discussion in the Arkansas Valley. <http://iri.columbia.edu/outreach/meeting/CPASW2005/Presentation/JWiener.pdf>; additional updating on the Colorado experiment, lessons learned, and on the economic observations. is available from the CPASW 2006 meeting, and other presentations listed below.) The project included agricultural modeling to better understand how water managers at the farm, ditch and basin levels can utilize climate information. This has been combined with continuing efforts at water user education and involvement in evolving water policy. Because of the continuing difficulties in implementing the water

bank and now the rotating crop management opportunity – two of the three institutions we claim are needed to realize climate-responsive water management, and which are now authorized – we continued to devote great effort to the policy process, in both Phase 2 of the Statewide Water Supply Initiative, and in the "Colorado Water for the 21st Century Act" Basin Roundtable process (see <http://ibcc.state.co.us/>). The theory and opportunities are clear enough; education, outreach, institutional design and the political process are not so clear. As of August, 2007, a second Water Bank project has cleared rule-making but its status is unclear. We have also met with the Department of Natural Resources Manager for the Interbasin Roundtable project that acts to facilitate water planning across basin boundaries. Public attitudes and official opinion reflect increased awareness of the importance of climate information and are becoming increasingly favorable to the several forms of water marketing as a management tool. We also provided a decision-support tool for individual farmers' decision-making, by sub-award to Dr. Jeffrey Tranel utilizing the information already compiled for the farmer's I.R..S. Schedule F tax information to establish a completely individualized "floor" price for leasing water, based on the most recent summary of the individual farm's business inputs and outputs. This complements assorted other support for crop choices and irrigation management, such as Crop Water Allocator (http://www.oznet.ksu.edu/mil/cwa/) and Water Optimizer (http://real.unl.edu/h20/), which were developed for Kansas and Western Nebraska irrigators, and the widely-used irrigation scheduling decision support tools (e.g. Colorado's "Crop-flex", or Kansas' "Kan-Sched"). Another on-going modeling effort is aimed at deriving "offer curves" of the various potential market participants which are essential features of a market process. In a water market, a participant's offer curve shows how much of a decision unit's available water supply would be offered to other participants at an ascending scale of prices. Offer curves can determine profitable sales and/or purchases among the various water market participants. This was deferred due to the lack of water bank empirical data with which to assure realism. Further turbulence has resulted from important shifts in perception of scarcity, particularly affecting urban interests.

B. Objective of Research Project (text limit one paragraph)

The major objective of this project was to increase the capacity of public and private water-related agencies to adapt to climate variation and climate change and, in general, to improve the economic efficiency of water use in Colorado We sought this by providing information, public education and research findings concerning water banking potential. Climate responsiveness must occur within adaptation to additional water supply stresses currently affecting water markets and politics, and avoiding hindrances to climate response as well as removing barriers to response. The pragmatic need is to include climate-responsiveness among the other goals and incentives affecting water management and agricultural water loss. So, the intermediate objective has been to remove obstacles to climate applications through inclusion in new institutions that promote more immediately-felt needs and goals such as agricultural water security and management improvements.

C. Approach (including methodological framework, models used, theory tested) (text limit one page)

The basic methods have been the application of economic theory to water management alternatives, involvement in the public policy process, and public education involving extensive interviewing and wide participation in the public policy venues noted above. Particular tools developed towards these ends included preliminary linear programming models of decision-making at the farm and ditch levels (Howe & Goemans) and spread-sheet based modeling for individual decision support by Dr. Jeffrey Tranel, sub-awardee. In support of the public policy process, an on-going series of products include numerous situation-specific materials for policy discussions and participation in technical and policy processes in water management, and presentations of a wide variety of materials at many water and agricultural meetings in Colorado, and nearby, and at professional meetings to elicit comment and interest.
The farm and ditch level programming models further understanding of the processes by which individuals or organizations are motivated to take part in water markets (it seems unlikely that the models can contain enough detail to be used by a particular farmer or ditch company; hence the individualized decision support

by Tranel as a separate tool). The models derive the offer curves of the various potential market participants A participant's offer curve is an analytical representation of the participant's willingness to buy or sell water at an ascending scale of prices. The set of participants' offer curves can determine profitable sales and/or purchases among the various participants. The modeling process starts with the individual farm and its selection of cropping pattern under its acreage and water constraints. The water constraint results from forecasted climate conditions. Assuming the maximization of short-run net income, the farm selects the maximizing cropping pattern plus the sale or purchase of water. Naturally, any potential market participant, farm seller/buyer or urban buyer, can be either a seller or buyer, depending on cropping profitability and the water market price level. With differing farm land and labor endowments, there will be opportunities for farm-to-farm sales and farm-to-urban sales. Once these sales are accomplished, it is possible to derive the offer curve for the ditch as a whole. Ditches can then trade among themselves or with urban buyers. Howe has continued active involvement in the analysis of water markets and how they can be improved (Universities Council on Water Resources, July 2006 presentation with Wiener. Wiener is applying the rationale elaborated previously (see CPASW 2006, 2005 presentations, AMS 2002, 2003, 2004 presentation/extended abstracts) to participation in the water bank rule-making, analyses of objections and research on answers, participation in the Statewide Water Supply Initiative processes, phase 1 and phase 2, and in the "Interbasin Compact Commission Basin Roundtables" process. Howe, Wiener and Goemans were visited by the Department of Natural Resources project manager for the Interbasin Compact Commission process to discuss development of water market. The understanding thus sought became highly problematic. Most of the information needed remains proprietary in a highly charged competitive market complicated by important shifts in public understanding of scarcity, urban demands, and finally climate change. This shifted emphasis to the policy issues, away from the modeling efforts. Despite the frustration of our intended subject, the Arkansas Water Bank Pilot Program, policy progress has included Statewide Water Supply Initiative technical roundtable support for the changes we believe are needed for climate-responsiveness, and political support from officials, and appointed advisory groups (the Interbasin Compact Commission, and most recently the South Platte Advisory Task Force).

D. Description of any matching funds used for this project (text limit: one paragraph)

This project was funded for a few months' FTE, and in effect the continuing investment of unpaid time by the investigators has been a match much greater than the original funding. The cash outlays for travel expense have been spread as far as possible, in furtherance of the goal of maximizing participation, credibility and contribution. We note also that every interaction by the whole set of policy-makers and advisors helping us develop the products for policy discussion was in effect a contribution as well.

II. Interactions

A. Description of interactions with decision-makers who were either impacted or consulted as part of the study; include a list of the decision makers and the nature of the interaction; be explicit about collaborating local institutions. (text limit: half page).

In addition to many individuals from Co-Operative Extension, the Office of the State Engineer, USDA Natural Resources Conservation Service, USDA Resource Conservation and Development, USDA Agricultural Research Service, and Colorado State University, we have had continuing interactions with dozens of participants in the Statewide Water Supply Initiative Technical Roundtables (as "technical advisor" for 3 of the 4 groups) and the new Basin Roundtable, particularly for the Arkansas Basin, the Guidelines for Water Transfers Committee (service as "advisor"). Each appointed participant represents a constituency, such as municipalities in a county, or a group such as small water providers, or recreation interests. Our involvement in this process has been welcome because of our persistent efforts to supply useful background information and updates on relevant topics as they arise (through a series of memoranda and notes and remarks; many are collected and available on request).

We maintain contact with the agency officials and the group of advisors with whom we frequently consult. We also maintain occasional interactions with the Ditch and Reservoir Company Alliance, and the Central

Plains Irrigation Association. We continue to appear at various annual meetings (Arkansas River Basin Water Forum, South Platte River Basin Forum, Colorado Water Congress), hearings and discussions, as well as scientific and professional meetings involving decision-makers. We are also in occasional interaction with board members and management of the Southeastern Colorado Water Conservancy District, Upper Arkansas Water Conservancy District, and Lower Arkansas Water Conservancy District.

B. Description of interactions with climate forecasting community (i.e. coordination with NOAA climate forecasting divisions….) (text limit: half page)

Interactions continue with the Western Water Assessment RISA project (Howe) and the Climate Prediction Applications Science Workshops (Wiener). We interact with others working in agriculture and water applications on a casual and persistent basis (e.g. organization of panel discussion for 2004 CPASW meeting, reported afterward and posted on website for CPASW 2005 meeting), and occasional interactions with NWS (Dr. Doug Kluck, Central Region, occasional events held in Boulder). Howe is also working with the NIDIS project based an Nebraska and NDMC, on a continuing basis.

C. Coordination with other projects of the NOAA Climate and Societal Interactions Division…. (text limit half page)

We maintain contact with other NOAA-supported researchers in the RISA program through Howe's participation in the Western Water Assessment project, and Wiener's involvement with CPASW and other researchers from the other NOAA meetings prior to that. Substantively, our efforts reflect many insights from others working in agricultural applications of climate information (SECC, primarily, and Dr. Mike Crimmins in Arizona with CLIMAS), and the policy learning developed by Hartmann and CIG (with whom Wiener has indirectly linked through collaboration with Richard Slaughter). Although separate from WWA funding and projects, we maintain complementarity with them.

III. Accomplishments

A. Brief discussion of research tasks accomplished. Include a discussion of data collected, models developed or augmented, fieldwork undertaken. (Text limit: 2 pages).

Wide-ranging interviews with discussion of why people opposed institutional reforms needed for climate-responsive management have resulted in additions to the research agenda. The most intensive discussions were within the Statewide Water Supply Initiative process, with a wide variety of water managers and users. Our original intent was to apply standard state "enterprise budget" information to decision support for agricultural water management, and we diverted effort from that because it had already been in development (see http://www.oznet.ksu.edu/mil/cwa/ and see <http://real.unl.edu/h20/ >). We explored converting these models for direct use in the "lease or not lease" application, with Natural Resources Conservation Service District Conservationist John Knapp and Dr. Lorenz Sutherland of the NRCS, and Dr. Jeffrey Tranel of Colorado State University Agricultural Economics and Co-operative Extension. The result was the decision to develop a completely individualized "lease or not lease" support that would be as simple and straight-forward as possible. The spreadsheet-platform model applies information that is taken directly from the federally-required schedule F form for farm income and expenses, filed with the IRS 1040 form. This is as individualized as such a tool can be, because it takes into account the farm-specific outcomes of past practice. Users can estimate future years by adjusting the figures as they wish, with intuitively obvious reflection of prices and costs as well as yields. With the information provided, users would then turn to the most suitable version of Crop Water Allocator or Water Optimizer to develop scenarios for management options if they wish. The individual irrigator decision support tool developed by Dr. Tranel under sub-contract has been peer-reviewed and is ready for testing by potential users.

The following topics were reviewed and synthesized for the SWSI Phase 1 discussions, and the HB1177 Basin Roundtables: (1) Discussion of water management goals and criteria; (2) Interpretation of self-reporting results from SWSI Phase 1, focusing on the systematic biases from tax incentives and municipal competition; (3) Risks and unforeseeability (4) Discussion of the roles of the State; (5) Small acreage farms as a factor in water demand; (6) Urban amenity values and the agricultural legacy in the West; (7) Agricultural efficiency and environmental values; (8) Rural sustainability and agricultural viability; (9) Climate variability and change as described in sectoral and regional assessments (USGCRP and more recent). (A set of collected memoranda is available on request, from Wiener).

Public statements and formal presentations in fora such as the Colorado Water Congress, Colorado Water Workshop, Arkansas Basin and South Platte Basin annual regional meetings, and the Basin Roundtables are efforts contributing to institutional change, especially in the acceptance of water markets. In the Arkansas Basin Roundtable established for the Interbasin Compact Commission process, the first drafts of the subcommittee on interbasin transfers all included endorsement of water marketing. The last year has also seen climate change "coming out of the closet" in public discourse conclusively in 2007.

The analysis of the failed "first water bank" is a significant contribution, exhibiting perspectives from the diffusion of innovations literature, agricultural innovation and methods of cooperative extension. (See Wiener 2005). The practical implications for design of the water bank relate to (1) Water eligible for transfer: inclusion of direct-flow rates to parallel existing short-term leasing authority seems warranted; (2) Duration of contracts: the desirability of contracts lasting more than one year depends on availability of other leasing authority (e.g., current Colorado law allows "interruptible supply" leases for drought responses but only for a short term, and only for a maximum of three uses within ten years, which defeats long-term stability of supply and does not serve short-term flexibility); (3) Timing: design features for notice to others and time for objection made operation take longer than three months, which defeated short-term flexibility and the intent of the mechanism in most applications; (4) Geographic scope: the legislation originally called for an in-basin preference, which was implemented with additional delays and steps, and the succeeding legislation prohibited use of the water bank for inter-basin transfers; the most lucrative markets are often in trans-basin municipalities, though development of an in-basin market and prices may be important to help establish reasonable values; in addition, the importance of social acceptability for innovations was demonstrated; (5) Price negotiations both within an internet tool and outside of the tool are desirable, but parties setting prices and deals outside of the mechanism should not be able to evade administrative costs and degrade the mechanism; social acceptability and further definition of the benefits of using the mechanism are topics for further inquiry; (6) Physical Infrastructural requirements to enable individual choice within a ditch system are in place in some ditches, and not on others, and additional investment may be one-time but substantial, inhibiting small transfers not made by all of the ditch acting collectively; (7) Accounting and management problems will require effort, for cost and benefit allocation; (8): Price discovery remains an important problem where markets include only infrequent transfers and disparity between very small transfers and rare very large transfers, and prices may be affected by new mechanisms allowing more flexible use and creating new markets. (A memorandum is posted with Wiener 2005 CPASW posting.)

The research in a larger sense has been an experiment in providing a collaborative sort of informal consultancy. As a preliminary finding, we feel that combining fieldwork of involvement with traditional academic work is valuable to both inform the academics and to get beyond the retrospective diagnosis tradition, toward change assistance. Our field work validates several hypotheses regarding administration. First, "if you are winning, you probably like the rules." (See UCOWR 2007 Wiener presentation or extended abstract). Second, the historic limitations on uses of water rights have contributed to the under-valuation of public interests in water. Third, self-organization of under-represented water interests has been slow. For example, the watershed discussion has tended to focus more on water quality than quantity in Colorado. Fourth, the rural economies and agricultural sector have been unable to effectively organize as collaborators with urban interests, asking for agricultural support for their interests in water. So far, we know of no such requests accompanied by offers of cash or cooperation. A significant bond issue (creating the Lower Arkansas Valley Water Conservancy District) was an indirect but important support. Fifth, drought and climate-responsive water management are well in hand for the large municipalities of Colorado. There are no apparent legal barriers to their traditional desired strategic responses, while rural

and agricultural transferors are still severely constrained in making long-term arrangements which could provide significant increases in security, stability, and adaptability as conditions continue to change in both physical and economic environments.

B. Provide two or three overheads of key research results in bullet form. (Suggested Limit: 5 bullets per page).

"HoweWienerClimateInformed.ppt" is sent separately with other appendices.

C. Elaboration of key findings (i.e., how this research advances our scientific understanding)

(Text limit: 5 pages)

Regarding the economic modeling and obstacles to it, please see discussion above. Here, to provide substance to the description of involvement in the policy process and provide information potentially useful elsewhere, we provide the following summaries. They are digests of the efforts to support creation and implementation of the changes needed to enable climate-responsive water management in this area, and they are also summaries of research into economic, legal, and institutional design problems.

THREE FORMS OF WATER TRANSFER SEEM TO MEET DEMANDS

Three forms of transfer appear to meet known needs, with the existing agricultural loans authority and the existing substitute water supply program authority (and maybe a few plain old sales too.). These are alternatives to "buy-and-dry" for many purposes. Discovering value "in-basin" may support better prices "out-of-basin."

1. LONG-TERM ROTATIONAL CROP MANAGEMENT: Features: long-term contracts, should follow principles elsewhere described. Transferor organization allocates "fallow" internally, water not used for irrigation is transferred. The water rights are obligated to the transfer however the contract specifies. No other rights or property need be constrained. It is increasingly important that these forma all avoids revegetation requirements for land formerly irrigated.
Expected Use: Base-load water supply for M&I, perhaps high-capital agricultural use.
Financing: Up-front infrastructural investments in conveyance; could be shared among cooperating users; spreads annual water payments for good match of costs and benefits for users; avoids use of municipal bonding capacity for water acquisition, though bonding should be considered for infrastructural investments, to match costs and benefits over time (pay-off in large measure by tap fees for new supply). Transferors would likely receive initial infrastructural improvements (e.g. Highline-Aurora-Co. Springs lease) and subsequently annual payments for water, fallowing expenses, etc. Parties should negotiate all details of payment. Ditch and Reservoir companies are parties as well as their shareholders. Asset value retained by irrigators; facilities, capacity, socio-economics more stable, less adverse than "Buy-And-Dry".
Authority: May have been possible; now have C.R.S. 37-92-103, -305. Should include water court process since long-term arrangements are involved (decades). Standards for acceptability of prior determinations of transferable fraction are needed. Adoption of suggested principles as refined, by rulemaking.

2. LONG-TERM INTERRUPTIBLE SUPPLY CONTRACT: Features: long-term contracts, similar to rotational crop management, except that transfer of water is not as predictable.
Expected Use: Firming, with three main applications: (1) *dry-year and post-drought recovery* "calls" on schedule of price adjustments to account for time when option exercised, cover expenses; (2) *facility-out-of-service* substitutions, same schedule of price/time of call; (3) *wet-year calls* at different set of prices to enable storage filling, aquifer storage or recharge, etc. while farmer uses wet year for not, less or differently irrigated crops; could involve negotiated risk sharing arrangements, etc.
Financing: Similar to LTRCM, with difference of schedule of prices to reflect different expenses or investments depending on time of call for use of option; probably annual payment for retaining option (income stabilization for irrigator and ditch company). Also avoids revegetation requirements.
Authority: Would be similar to LTRCM. Because long-term, careful adjudication warranted. NOT authorized in current C.R.S. 37-92-309, which is limited to 3 of 10 years and 10 year term.

3. WATER BANK: Features: short-term contracts, reversible transfers, very low costs, very quick changes; affordable fast small deals. Duration of approvals limited to 3 years (2? – intent to fill gap if needed while long-term arrangements are made, but should not be substitute. Could even be 18 months, if substitute water supply authority currently available is retained.)
Expected Use: "spot market". Flexibility for surprise needs, surprise opportunities (e.g. expectations for markets due to local or competitor region conditions), and for security of investment in high-capital technology where infrequent needs arise to maintain investment (e.g. fruit trees, greenhouses). (Northern District: 1/3 of transfers (1/4 of volume moved) of CBT water are "ag-to-ag"; see Howe and Goemans in Colorado Water, 2002, or Journal of American Water Resources Association, 2003.)
Financing: Ad hoc, by definition. Any source available, deals as negotiated.
Authority: Similar to current water bank authority (C.R.S. 37-80.5- 101 et seq.) but not limited to in-basin, maximum duration to be specified to distinguish from Interruptible Supply deals; procedural clean-up may be required (Wiener, "next steps" memorandum; other presentations available); and add specification that potential transferors may seek pre-qualification (e.g. show adequate prior determination of HCU).
Proposed second water bank makes progress. Price discovery and information is still a current need for these activities.

SUGGESTED PRINCIPLES FOR WATER TRANSFER INSTITUTION DESIGN –
Avoiding unintended consequences and creating participation to provide certainty

1. Role of the State "Referee" for technical and administrative management, to protect property rights including but not limited to water rights. Defends interests in water quality, soil erosion etc., social impacts as directed, future conditions, and compliance with federal law and interstate compacts. Provides adequate information and institutions to allow successful markets and reduce transactions costs. Provides assurance of certainty of priority. Fosters capacity of local governments to identify and secure needs and interests, usually within markets.
2. Role of the Market Fair and reasonably transparent opportunity for trades of resources and arrangements for risk distribution and management. **Opportunity for third-parties and governments** to seek or preserve conditions they desire, for amenity, tax-related, recreational, environmental or other interests, by purchase, lease, easement or otherwise. Market allocation is preferred to political processes because it allows negotiation flexibility for unique needs and desires, and certainty of property rights. Use the market when adequately supported.
3. Certainty is an Essential Purpose Creation of successful alternatives to sale of water rights requires correct specification of property interests, and provisions for adjustment of deals, and adequate efforts to foresee and manage impacts and surprises. Impacts on transferor areas include regional and cumulative impacts, such as total changes in employment, habitats, species, salinity and flow impacts. Failure to anticipate thresholds and limits will threaten certainty. Therefore, the scales of impact analysis and the quality of assessment must be sufficient to anticipate adverse surprises which would remove incentives to avoid water rights sales. If the new program is launched without adequate efforts to provide certainty, surprises will favor some interests over others, and may deny achievement of the policy goals.
4. Allocation Within Thresholds is Important Failure to anticipate thresholds has been illustrated in the South Platte and Arkansas Basins where well users were abruptly brought into compliance with prior appropriation and in some cases taken out of business. (Abrupt adjustment is also underway in the Republican River area). However a limit or threshold arises, from water law, endangered species, a TMDL, or intent to retain some level of agricultural activity, there will be need to allocate within the limit. Parties hoping to join a market who discover that all permits or all capacities are taken may threaten the legitimacy and certainty of arrangements privately made which suddenly prevent other participation. And, reallocation may be important in the future.
5. Transferor "Internal" Allocation by Market Within transferor organizations, there are two sets of adjustments should be possible using market processes. First, resource re-allocation for public purposes, such as salinity reduction, or purchase of environmental conditions may be important. Second, individual situations may call for flexibility within transferor organizations such as mutual ditch companies. Farms and families may want different outcomes and things change. Certainty in the long term requires internal adjustability on the small scale, and proper scale to accommodate individual property rights and preferences while avoiding organizational crisis.

6. Scale Matters: Appropriate Collaborative Institutions Impacts are related to scale, and cumulative impacts are often regional. Identification of impacts and interests is somewhat new in relation to water transfers, partly because of the history of mitigation problems. New transfer mechanisms may need formal collaborative organization (co-ops? districts? ditch companies?) to manage impact assessment and allocate within self-organized areas. There may also be need for regional recreational and environmental consideration, to represent interests new to the market and identify opportunities for coordination and efficiency. Enabling wider participation using markets should more fairly match costs and benefits. Scale issues include areal extent of transferor organization, regional impacts and participant preferences, as well as costs of management and organization.

7. Permanence, Practicality, and Partnerships Buyers of water under long-term deals (e.g. 75 years) will not want to risk insecurity of supply if prices and supplies have changed – as they doubtless will. But, ownership and "buy-and-dry", or occasional lease-backs onto limping farm operations that won't support new technology and expense are not the only answers. Legally, this is leasing, but economically and practically, it is partnership. Deals can be designed to assure a fair chance for everyone at the end, or to postpone the end, and the value for everyone can be increased. The same people who pay water rates also voted 110 times in Colorado to spend $3.4 Billion dollars in taxes on conservation, open space, and farm and land preservation (Trust for Public Land "conservation vote" on website). Simplicity is not the only virtue! The government job is not only to "get water now as fast and cheap as possible" and forget the impacts. Real partnerships are possible and should be applauded and fostered! Cities may not be the best choice for managing farms, revegetation, and agricultural enterprise, but they can make wonderful exchanges with rural areas in education and other common purposes, such as educational, service location and needs, and jointly provided services.

CRISIS/OPPORTUNITY FOR DITCHES AND WHY IT MATTERS

CRISIS: Water will move to cities in Colorado and elsewhere. The feverish competition for water may move a great deal of water before management innovations can be fully developed (e.g. Denver Post by Olinger, et al. Nov. 05). Benefits and costs from this "state of play" are not evenly distributed, and the beneficiaries may like that. Ditch and Reservoir Companies are now a few hundred mostly small farming interests facing cities and water providers with bonding and financing capacity. If the ditch companies disintegrate (see below) and the market reduces to thousands of tiny individual water sellers or transferors, rural interests will be even worse off. This would adversely affecting rural future-opportunity interests, recreational, amenity, environmental and current economic interests. We are only beginning to allow and help the beneficiaries of agricultural water distribution and flows to enter the market.

OPPORTUNITY: There is now more support than ever for alternatives to "buy-and-dry" and mitigation or management impacts, as shown in the Colorado 64 Principles, adopted by all counties and the General Assembly (HJR03-1019), the SWSI, and the HB05-1177 Inter-Basin Compact Process (charter adopts Colorado 64). If the new tools can be developed fast enough to provide assurance of eventual success and reduce "water wars" and chaotic markets, the opportunity for greater rural stability and agricultural sustainability exists.

POTENTIAL BENEFITS: (see memoranda to SWSI, SWSI report itself, etc.) There could be:

- Agricultural income stabilization from long-term contracts of two kinds, likely involving both annual and "use of water payments" to transferor farmers, and ditch management payments for infrastructural and accounting innovations needed. Aurora and others set the pace with the Rocky Ford Highline Canal lease.
- Agricultural economy stabilization from sustainability of farming with great improvements in capitalization possible, retention of appreciation of the asset value, and continuation of the forward and backward linked businesses in the regional and local economies. ***Investment depends on a future***.
- Rural economy support from stabilization of these parts of the tax base and establishment of a more foreseeable and manageable future, enabling county cost management, resource allocation improvements, and increased attractiveness for small towns. Defense of the core activities and quality of life are necessary though perhaps not sufficient for regional rural revitalization adding incremental small business growth, tax-rational residential and second home growth, and cooperatively developed service improvements.

Municipal advantages: "pay-as-you-go" for water matches costs to benefits, avoids interest/bond debt, and avoids ownership of farms or revegetation obligations which may be unpredictably expensive and lengthy. May avoid major infrastructure if supplies replace (firm) drought-reduced supply.

ROLE OF DITCHES: We should treasure and defend agricultural water distribution for many reasons.

- Many of the richest parts of the rural landscape were created by water distribution, partly replacing the riparian areas converted to other uses and affected by flow regulation; the highest values in urban and suburban land reflect proximity to amenity, often ditches as linear parks and recreational ways, and reservoirs and other water features and environmental benefits to all, from the birds to the tax base.
- The groupings of interest that can act on the landscape, for better or for worse, are the owners of the land, and their interests rise and fall as the group together – this is ***social as well as physical capital***, symbolically and literally. New-comers want what these people created and we should support continued provision of these benefits, and allow a better market to develop including local interests.

SO WHAT? So, the profound conflict of Jacobucci (…v. District Court, 189 Colo. 380, 541 P.2d 667 (CO, 1975)) upholding individual ownership of water rights through mutual ditch companies as trustees versus the physical realities of collective ownership, management, and success or failure of the ditches and reservoirs threatens ditches with allocation, accounting and management problems which could result from inadequately managed very serious conflicts over opportunities. Ditch companies must survive this crisis and opportunity on their own or risk disintegration. Internally, they must prepare for this. Externally, what they can do with their assets now could be done by speculators and developers, but would outside financial interests care for local desires and aspirations for the land and people? Put another way, why should the locals always lose control? New water transfer opportunities and finances along with new partnerships that help rural areas might support a more adaptable and sustainable economy and community.

Table of transfer alternatives – When to Use Which.

The number in cell is estimate of how well the form with specified additions meets goals from the transfer; 3 is best, 2 is moderate, 1 is small, 0 is not at all. "Full Participation" refers to participation in the exchange by all interested parties, including agents for State interests, local governments on behalf of their constituents' present and future interests, and recreational and environmental interests. Parties may participate in exchanges using cash, using persuasion, or using other considerations such as easement incentives, local government provision of benefits, or other legal means. All exchanges are voluntary and take place only if all parties to them agree. Parties unwilling to accept other parties' terms need not do so. **Note 1:** All transfer forms are presumed to be developed and implemented in good faith with responsible terms in a reasonably working adequately informed market. **Note 2:** Purchase for the particular goal would help it; purchase for some other reason would have no effect or negative effect depending on the case in point and the use of land after the transfer. **Note 3:** Effects of conservation easements or similar land-use and water-use dedications will vary with the intent. Arrangements might accommodate interruptible supply or emergency leasing if compatible with the purposes of the easement. The easement might coincide with salinity reduction or "get off bad ground" purposes, also, depending on the purposes and the other qualities of the land. Finally, the easement may secure environmental, recreational, and local amenity values.

RCM = Rotating Crop Management; ISK = Interruptible Supply Contract; ST = Short Term

Table Summarizing Uses of Alternative Forms of Water Transfer

Form of Transfer	Buy and Dry	RCM	RCM + Full Participation	ISK (long term)	ISK + Full Participation	ST Lease	ST Lease + Full Participation	Conservation Easement
Goals from transfer								
Urban "base-load" supply	3	3	3	1	1	0	0	0
Urban occasional supply	2	1	1	3	3	1	1	0 N.3
Urban quick need unforeseen supply	1	0	0	1	1	3	3	0 N.3
Storage	2	2	2	3	3	2	2	0 N.3

opportunity								
Agricultural stability	0	3	3	3	3	2	2	2
Ag. Sectoral support	0	3	3	3	3	2	2	2
Form of Transfer	Buy and Dry	RCM	RCM + Full Participation	ISK (long term)	ISK + Full Participation	ST Lease	ST Lease + Full Participation	Conservation Easement
Goals from transfer								
Ag. Income immediately	3	2	2	2	2	3	3	1
Ag. Flexibility for farmers	0	3	3	3	3	3	3	0
Ag. Tech. change	0	3	3	3	3	1	1	1 N.3
Ag. Move off less productive	1	3	3	1	2	0	0	2 N.3
Water quality (salinity)	N. 2	1	3	1	2	0	0	2 N.3
Envt'l. habitat	N. 2	1	3	1	3	?	3	3
Envt'l. cumulative impacts	0	3	3	1	3	0	0	3
Recreational opportunity	N. 2	1	3	1	3	0	1	3
Local amenity values	N. 2	1	3	1	2	0	1	3
Community stability	0	3	3	3	3	2	3, N. 2	1
Community development betterment	0	1	2	1	2	1	1	2 N.3
Economic diversification	0	1	2	1	2	1	2	2 N.3

D. List of publications and presentations arising from this project:

Howe, Charles W. and Christopher Goemans, 2003, "Water Transfers and Their Impacts: Lessons from Three Colorado Water Markets", Journal of the American Water Resources Association, Vol. 39, No. 5 October

Howe, C.W., Statement for Panel on Water Banking, Arkansas River Basin Water Forum, March 2003, organized by Wiener at request of Forum Committee; published as written by Ag Journal (La Junta, CO), and Pueblo Chieftain, Pueblo, CO.

Howe, Chuck and Chris Goemans, 2002, "Effectiveness of Water Rate Increases Following Water Restrictions", Journal of the American Water Works Association, October.

Howe, Charles W., 2000, "Protecting Public Values in a Water Market Setting: Improving Water Markets to Increase Economic Efficiency and Equity", University of Denver Water Law Review, Spring.

Wiener, John, 2004, Can You Use Your Ditch to Win Friends, Get Benefits and Shift Risks? DARCA News, 3(2):1-5 (Ditch and Reservoir Company Alliance, Longmont, CO); also website posting.

Slaughter, R. and J. Wiener, Water, Property Rights and Adaptation on the Snake and Klamath River, 2007, Journal of the American Water Resources Association 43(2): 1-14.

Formal presentations by Charles Howe:
Howe, Charles W., 2006, "Sharing Western Water Lessons with the Midwest: Experiences and Institutions", opening plenary speech for the Illinois Water 2006 conference, University of Illinois, Urbana, October 4, 2006.
Howe, Charles W., "Water As A Commodity: the Increasing Cost of Enforcing Property Rights in Water", opening panel for the 31st Colorado Water Workshop, July 26, 2006.

Formal presentations by Charles Howe and John Wiener:
2006 Presentation to Universities Council on Water Resources, "Moving Towards More Efficient Water Markets: Institutional Barriers and Innovations." Santa Fe, July.

Formal presentations by John Wiener:
2007 Presentation to Universities Council on Water Resources, " Drought, Climate Change, and Colorado's Policy Discussion: Participation or Procrastination?", Boise, July. Extended Abstract and Presentation available.

2007 Presentation to Climate Prediction Applications Science Workshop, "Adaptation of Hazard Response? Concern with Narrow Applications in Water Management", Seattle, March. Posted: <http://www.cses.washington.edu/cig/outreach/workshopfiles/cpasw07/agenda.shtml>

2007 Presentation to USDA CSREES National Water Program Meeting, "The Climate of Insecurity for Colorado's Agricultural Water – Management Responses and Coordination of Objectives", Savannah, January 2007. Posted: <http://www.usawaterquality.org/conferences/2007/abstract_index.html>

2007 Presentation to Colorado Water Congress, "Moving Toward Climate Responsive Water Management", Denver, January 2007. (Available).

2007 Poster and Detailed hand-outs: Ditch and Reservoir Company Alliance Annual Meeting, Sterling, CO, February 2007. (Available.)

2007 Poster and Detailed hand-outs: Central Plains Irrigation Association Annual Meeting, Kearney, NE, February 2007 ((Available), and informal report to Board meeting).

2007 Poster and Detailed hand-outs: Arkansas River Basin Water Forum, April, 2007, Salida, CO.

2006 Presentation to US Committee on Irrigation and Drainage, and Proceedings, "Looking for Trouble: Anticipating Impacts of Changing Allocation of Irrigation Water", Boise, October. Extended abstract in Proceedings, available from USCID or author.

2006 Presentation to Society for Conservation Biology, "Looking for Trouble: Unpredictability of Effects of Water Transfers away from Irrigation in the Western U.S." San Jose, June. (Available.)

2006 Presentation to American Society of Civil Engineers, Environment and Water Resources Institute, and Proceedings, "Responding to Concerns about Flexibility in Agricultural Water Management in the Western U.S.: A Climate of Uncertainty". Omaha, May. (Available.)

2006 Presentation to Climate Prediction Applications Science Workshop, and proceedings, "Be Careful of What You Wish For… Climate-Responsive Water Management from the Ground Up Goes Big-Time?" Tucson, AZ, March. (Posted)

2006, Organization, Presentation of Context and Issues, Reporting of Workshop on Farm-Management Issues in Water Transfer Reform, with David Yates, in association with Central Plains Irrigation Association, Colby, February.

2005: Presentation, Drowning in the Rapids? First Runs in the Arkansas River Basin Water Bank Pilot Program, American Water Resources Association Annual Meeting, Seattle, WA, November.

2005 Presentation, "Adopters, Constituents, or Customers? Suggestions from the Colorado Water Bank Experiment for Climate Prediction Applications Promotion", 3rd Climate Prediction Applications Science Workshop, International Research Institute, Palisade, NY, March. http://iri.columbia.edu/outreach/meeting/CPASW2005/Presentation/JWiener.pdf

2004 Presentation and paper, "Water Banking in Colorado: An Experiment in Trouble?", at U.S. Committee on Irrigation and Drainage Annual Meeting, Salt Lake City, UT., October; proceedings volume, Water Rights and Related Water Supply Issues, pp. 515-525.

2004 Presentation, "Small Agriculture Needs and Desires for Weather and Climate Information in a Case Study in Colorado" (John D. Wiener, presenting work by Wiener, Charles Howe, and others), NOAA National Weather Service Central Region Sub-Regional Climate Services Meeting, Boulder, CO (central region website posting).

2004 Moderator, co-organizer, Slow-Onset Hazards panel, Natural Hazards Research Applications and Information Center Annual Workshop, Boulder, CO.

2004 Organizer, moderator, reporter of Roundtable Discussion, "Learning From and About Cooperative Extension Services", Climate Prediction Applications Science Workshop, Tallahassee.

2004 Presentation at American Meteorological Society Annual Meeting, "Small agriculture needs and desires for weather and climate information in a case study in Colorado", Seattle. (Extended abstract available electronically and from AMS.)

2004 Poster presentation, at American Meteorological Society Annual Meeting, "Moving Water from Theory and Farms: The Colorado Water Bank Experiment", Seattle. (Extended abstract available electronically and from AMS.)

2003 Presentation "Water Bank and Ditch Interests", to Grand Valley Irrigation Company Board of Directors, Grand Junction, CO.

2003 Presentation at Colorado Section, American Water Resources Association, Annual Meeting, "Moving Water in Drought and the Arkansas Water Bank Pilot Program So Far – Observations from an Outsider", Golden, CO

2003 Presentation and panel organization, "Water Banking and Interruptible Supply Contracts", Arkansas River Basin Water Forum, Pueblo, CO

2003 Presentation at Ditch and Reservoir Company Alliance First Annual Convention, Durango, CO, "The Colorado Experiment in Water Banking: Informal Review for DARCA" (available electronically and from DARCA website)

2003 Presentation at American Meteorological Society Annual Meeting, "Water banking as adaptation to climate variability: the Colorado experiment". Long Beach (Extended abstract available electronically and from AMS.)

2002 Presentation at Climate Prediction Assessments Workshop, Alexandria, VA: "If this is so simple, why is it such a mess? Climate Forecast Applications, Irrigation and Water Banking in Colorado" (Extended abstract available electronically)

2002 Presentation and panel moderator at Principal Investigators' Meeting, Office of Global Programs Economics and Human Dimensions Program, Seabrook SC, "Constraints and stumbling blocks in use of climate information" (abstract available electronically)

2002 Presentation at American Meteorological Society et al. Mississippi River Climate and Hydrology Conference, New Orleans, May, "Moving Water: Water Banks, Forecasts, and Obstacles." (Extended abstract available electronically on request).

2002 Presentation at American Meteorological Society Annual Meeting, Orlando, January, "A Simple Approach to Increasing Usefulness of Forecasts". Orlando. (Extended abstract available electronically and from AMS.)

E. Discussion of any significant deviations from proposed work plan (e.g. delayed fieldwork due to later arrival of funds). (Text limit: one paragraph).

Fieldwork was initially delayed due to funding transfer delays, but including the period of no-cost extension, we have stretched the project for as long as possible for two reasons. First, we wanted to respond to the threat to the whole idea of a water bank (and new forms of market-driven reallocation) as highest priority, and that mission carried into the Statewide Water Supply Initiative Phase 2 after Phase 1 was completed. Second, after being convinced that there would be demand for decision-support for a climate-informed water management institution, we faced the problem of how to effectively achieve that without adequate empirical data. The pleasantly academic project involving agronomy and farm management modeling would extend uses of existing and accepted tools within an environment in which demand for such support would increase. We were instead pushed into continuing substantial involvement in the policy process in order to keep forward momentum toward the means by which climate-responsive management can be implemented (the reforms in how water is transferred). The need to persuade and promote regarding institutional change became paramount as public interests and perceptions shifted very radically while information about water markets was actually being, in some cases, deliberately falsified (see Olinger and Plunkett, 2005, Denver Post series, November. Text file available on request; full story and graphics on <DenverPost.com>. We have been gratified by sharp increases in appreciation for the reforms and growing pressure for their realization, and subsequent projects have focused on helping with implementation problems. This project bridged an important gap, between identifying opportunities for application of climate information and using legislative authorization and popular support, but not quite in the way we intended or anticipated.

IV. Relevance to the field of human-environment interactions

A. Describe how the results of your project have furthered the field of understanding and analyzing the use of climate information in decision-making. (Text limit: one page)

This project is a case study on a regional and State level of institutional innovation in the field of water law, to enable climate-responsive water management. Climate response is much less important to the relevant actors in this case than drought response, and within drought response there are much greater efforts in municipal supply provision for the benefit of cities than for agricultural water security, to use the USDA phrase. Within agriculture, drought response has been traditionally pursued as a matter of financial support rather than attempts to reorganize or reallocate water supply. There has been attention to reallocation in the area of the South Platte Basin in Colorado in 2006, following many years in increasing tension between short-term institutional solutions and long-term attempted uses of well irrigation in conflict with prior appropriation, but although the crisis was precipitated by the drought centered on 2002, it had been pending for decades. In the study area, ground water regulation has been in place longer, precipitated by interstate compact compliance obligations, so institutionalized responses are in place. The interesting point about climate information in decision-making is that Colorado has undergone substantial policy formation and political controversy in response to current drought and the increasingly well-appreciated “paleo-drought” information from Woodhouse and others, showing the extent of past droughts before the historic record. In 2007, at last, Colorado water leaders (with the exception of Eric Kuhn, who has also worked with WWA), have demonstrated a public concern for climate change. The extent of concern or acceptance in agricultural

leadership is not clear. Instead of directly addressing climate change alone, we are pursuing response capacity and ability to adapt by means of response to drought and population-driven transfers of agricultural water. It is therefore dubious to credit progress (e.g. legislative action) to acceptance of the climate-applications goals which motivate our project.

The use of climate information has been constrained by the inability to transfer water on an intermittent or interruptible supply basis, and the inability to manage as theoretically desirable. Therefore, market structure and legal forms have been needed to implement recommendations for climate-responsive water management. As described above, this task is a precondition to successful climate information applications, so it has taken precedence. The modeling accomplished and underway will provide decision support for irrigators, groups of irrigators, and municipalities considering use of climate-responsive management techniques.

The work (and continuing dissemination of work, e.g. September 2007) on the failure of the "first draft" water bank as a failure of agricultural innovation (among other problems, and as distinguished from a legal innovation) is a contribution to the understanding of climate information applications in this sector. It is not known how well the traditions of the agricultural sector mirror those of other sectors; in some ways, agriculture is remarkably receptive to new information (e.g. field trials of available cultivars by each state are of considerable interest) and in some ways the need to limit risk, and to manage on a financially short-term basis has made agriculture apparently uninterested in innovation. Continuing severe fiscal constraints continue to limit use of traditional extension and demonstration even where need may be recognized.

B. Where appropriate, describe how this research builds on any previously funded HDGEC research.... (Text limit: half page).

This project extends the case study begun earlier, with work on the principal obstacle to use of climate information in the Arkansas Valley of Colorado. The analysis of failure of the water bank pilot program was particularly related to other HDGEC work, culminating the report on the CPASW panel discussion and annotated bibliography on "learning from and about extension". This was, we hope, a valuable addition to the Jacobs Handbook on informing policy. The on-going interactions and policy development have shown that scientifically-motivated policy innovations can be badly entangled with other agendas (no surprise), and we informally confirm the experience of many of the RISA projects in an important issue. That is, that climate applications per se are probably always going to be easier to implement than climate adaptation where that requires institutional change. We are also seeing difficulties for adoption of changes that must be addressed in traditional policy settings and terms, regardless of technical solidity and technical lack of controversy. Much of what we identified and hoped to promote, for example, has been well advanced (in appropriate parallel) by the Southeast Climate Consortium. There are working examples of many of the institutions we sought in other places (e.g. Idaho water banks). But here, getting to the most-needed climate applications means getting past serious political change problems.

C. How is your project contributing to the following areas of study? (Text limit: one paragraph per relevant area)

1. Adaptation to long-term climate change:

Please see IV. A, above. To add a point for general application, we are another example of importance of presence, persistence and participation in efforts to achieve implementation, perhaps especially where that requires working through many potential vetoes or obstacles. By "presence" we mean establishing credibility with potential users of new information and ideas who cannot independently evaluate them; they may have to know the proponent well enough, instead. By "participation" we mean working on "their" issues as well as ours, to show contribution and commitment and develop working relations. By "persistence" we mean nothing surprising: these processes may take years, and are certainly subject to all

sorts of other influences, especially where many groups and interests are involved. We still hope to do some nice clean economic modeling and analysis if we can get to markets clean and open enough to get adequate data with which to complete work begun (particularly following up Howe and Goemans' work, published in Journal of the American Water Resources Association).

2. Natural hazards mitigation:

Successful establishment of more adaptive water management would increase resilience to drought, but does not appear obviously related to other hazards. There is an analogy between urban-wildland fire hazards as a case of moving into danger and development of residential subdivisions and towns with inadequate water supply, but there has been no public interest in following this analogy, despite some agency officials' interest. Meanwhile, we working with the combined influences of drought and aggravation of scarcity by radical increases in demand as the major impetus for popular support, though we know that the largest and most professionally-staffed water providers are also working on climate problems and supply vulnerability. A new issue, recently emergent from the studies of feasibility of alternative forms of water transfers in another project (Yates and Wiener, Research Support for Climate Responsive Water Management….) is the linkage – or disconnect – between climate information applications as a short-term optimization in resource management versus the desirability or sustainability of long-term continuation of practices which may not be well-advised (e.g. agriculture involving productivity with high inputs but also high exposure to increased erosion problems; see Wiener 2007 CPASW presentation.)

3. Institutional dimensions of global change:

Given the framework of private property rights in water this case is an effort to establish new markets and modify the legal framework. There is no acknowledged link between the surprisingly active legislative response to water law reforms and global change. But, perhaps this is usefully seen as a "no regrets" adaptation: no matter what climate does, increased adaptive capacity is beneficial, and improved markets should be beneficial, so the short-term more visible goals may be sufficient to motivate adaptation. Despite the rationality of the desired changes, however, there is also a lesson here about the value of the status quo to large and technically adept organizations which can exploit conditions effectively and will defend those conditions if advantage may be lost. (See UCOWR 2007 Wiener for discussion). One of the emerging problems faced in the policy discourse in this and the later projects in the series is the need to engage missing parties in the new or improved markets. Markets that work better in terms of more flexibility but which still create enormous and controversial social and environmental externalities are not ideal; we hope to add wider participation to the improved functioning, and that requires inducing or assisting those missing interests to take a more proactive and participatory position than they have. The larger lesson is that fixing part of the problem may only aggravate other problems if one is not very careful.

4. Economic value of climate forecasts:

The irrigator's decision support tool, using information from the farmer's Internal Revenue Service Schedule F form, helps establish the individual's value of water. The value of forecasts, however, would be the net value of increased incomes and well-being when the water leasing alternative is used in response to climate, including benefits to transferees as well as transferors and their resources.

5. Developing tools for decision makers and end-users:

The problems with data and sufficiency of transactions to complete modeling as intended led to many consultations on how else to serve the intended beneficiaries, and we are very pleased that our sub-award to Dr. Tranel produced a very thoughtful approach and a tool now made available to users. (Appended). This is discussed above. It is a small Xcel ™ spreadsheet easily e-mailed and easily applied by a farmer or farming business, and applicable to aggregated information should a ditch company wish to combine information from individuals.

6. Sustainability of vulnerable areas and/or people:

Rural plains areas and agriculture are highly vulnerable and severely stressed; since we began this project, additional impact assessment work has only confirmed that position. With the examination of the new forms which we identify as the essential changes for optimal management, we have raised the issue of how long-term economic stability could affect these vulnerable areas and economies. Howe has previously provided the best assessment of the economic dependence of the study area on agriculture, and the linkage to irrigation is established elsewhere in Colorado Department of Agriculture work. The livestock feeding business depends on cheap feed, available in part because of shorter transportation and in part because of a climate suitable for both cropping and cattle management, and in part because of rural hospitality for these activities (in contrast, Omaha's branch of the University of Nebraska is now larger than remainder of the fabled stockyards). The agricultural sector is thus more dependent on irrigation than direct sales figures would suggest, since the livestock sales are several times greater than crop sales, though meat-packing also adds value and is not as tightly linked to local feed as cattle-feeding. The impact of the regional ethanol-from-corn boom and subsidies may be important in aggravating this problem. Agricultural irrigation water security is increasingly at risk in the West, in turn threatening domestic agricultural productivity in the long term (see Dobrowolski, J.P., M.P. O'Neill, and L.F. Duriancik, Eds., 2005, United States Department of Agriculture, Research, Education and Economics, Agricultural Water Security Listening Session, Final Report [of meeting September 9-10, Park City, UT], Washington, D.C., and <http://www.csrees.usda.gov/nea/nre/pdfs/ree_water_security.pdf>).

7. Matching new scientific information with local/indigenous knowledge:

This work relates to that goal in the sense that we observed and reported to State officials and others how the local knowledge traditions of the agricultural sector were disregarded in the attempted development of a new water institution.

8. The role of public policy in the use of climate information:

Please see above: since the drought of 2001 and forward and the growing alarm over supply and demand imbalance in municipal water supply, manifest in competition for supply, it may be that public policy on climate information is actually less important than before these influences began to dominate the water policy discussion in the US West.

9. Socioeconomic impacts of decadal climate variability:

No connection known, due to lack of clear linkage to Colorado conditions.

V. Graphics – please include the following graphics as attachments to your report....

A. Graphic depicting the overall project framework/approach

B. Graphic(s) depicting key research results

C. Map of region covered by study (if applicable)

D. Photographs from fieldwork to depict study environment.

Please see Powerpoint ™ presentations and additional slides sent as appendices to this report. They include slides on key research results, maps, and photographs, and also the slides requested above. Also, another appendix is the Xcel ™ spreadsheet "Lease Rate Calculator".